Lasers in Surgery and Medicine 21:29–31 (1997)

Holmium:YAG Laser and Pulsed Dye Laser: A Cost Comparison

Denise H. Adams, RN, BSN, CNOR*

Lutheran Medical Center, Wheat Ridge, Colorado 80033

Background and Objective: **This study was designed to evaluate the relative cost effectiveness of the Holmium:YAG laser and the pulsed dye laser for the treatment of ureteral calculi. Cost containment is a priority for every health care facility. As a result, the staff of the Lutheran Medical Center (Wheat Ridge, CO) looked at alternative ways to provide quality laser treatment of ureteral stones. As part of our study, the laser committee offered the Holmium:YAG laser to urologists for ureteral lithotripsy. Previously, the pulsed dye laser was rented for ureteral calculi on a per case basis at $1,500. A hospital processing fee was added to this cost, resulting in a total charge of $1,638 to the patient. Our organization owns a Holmium: YAG laser and uses it primarily in orthopedics.**

Study Design/Materials and Methods: **Two ureteral lithotripsy cases were performed and compared. One case used the Holmium:YAG for ureteral lithotripsy; the other procedure used the pulsed dye laser. A cost analysis was performed after the procedures.**

Results: **The data indicated a significant difference in cost between the two lasers. Approximately $1,000 was eliminated when using the Holmium:YAG laser.**

Conclusion: **A cost savings of $15,000 per year would be realized if 15 cases were performed. The Holmium:YAG laser also can be used on cystine calculi, a procedure for which the pulsed dye laser is ineffective. The potential for ureteral injury exists. When using the Holmium:YAG laser, appropriate training is required. Due to this risk, not all urologists will use the Holmium:YAG laser. We also found a positive correlation between the proficiency of the urologists' laser skills and overall cost effectiveness. Lasers Surg. Med. 21:29–31, 1997.** **© 1997 Wiley-Liss, Inc.**

Key words: Holmium:YAG laser; pulsed dye laser

INTRODUCTION

The pulsed dye laser was developed in 1967 by Dr. Horace Furumoto and Harry Ceccon. Since that time it has been the primary treatment of ureteral calculi, which cannot be retrieved by basket forceps. The pulsed dye laser, at 504 nanometers (nm), is green in color and highly absorbed by the yellow pigment of most urinary calculi [1]. This wavelength is absorbed minimally by tissue and hemoglobin. This property makes it safe to use with calculi impacted in the ureter, but ineffective against colorless cystine calculi. The process of laser energy being absorbed by the calculi creates a "plasma," or small cloud of highly excited ions and electrons. This plasma rapidly expands and contracts at the rate of pulsation (5–10 Hertz), causing an acoustic shock wave from the irrigation solution used during the procedure [2]. This mechanical action causes the calculus to break into passable fragments.

In 1991, the Holmium:YAG laser was approved for use in orthopedics. However, it was not until 1994 that the Holmium:YAG laser received

*Correspondence to: Denise H. Adams, Lutheran Medical Center, 8300 W. 38th Ave., Wheat Ridge, CO 80033.

Accepted for publication 13 September 1996.

FDA approval for the treatment of ureteral calculi. The Holmium:YAG laser is a solid-state crystal of Yttrium Aluminum Garnet scattered with holmium (a rare earth element). This invisible wavelength is at 2,100 nm. The Holmium: YAG is not color specific and is highly absorbable by water. When working in a fluid environment, the laser energy is absorbed while heating it and creates a vapor bubble. The vapor bubble is ~ 3 mm in length. If the target tissue is within that distance, the energy will pass through the bubble into the tissue. If the target tissue is outside of the 3 mm vapor bubble, no tissue interaction will take place. The laser fiber needs to be in direct contact with the calculus. If good visualization is not possible due to fragmentation debris firing of the laser should be suspended until the field is clear and good contact of the stone is made. The laser energy will drill holes into the calculus, leading to its fragmentation.

There is potential for ureteral injury if the fiber is misplaced against the ureter, guidewire, stent, or basket forceps. Instrumentation such as guidewires, stents, or basket forceps, which can be damaged from the laser, can cost anywhere from $100 to $300. The associated costs of ureteral tissue damage are unestimable. Most ureteral injuries require placing a stent, rather than open ureteralithotomy for repair.

MATERIALS AND METHODS

The Holmium:YAG laser continues to gain approval in different surgical specialties and procedures. Its increased versatility is an attractive feature that hospitals are realizing is a way to contain costs. Purchasing a laser with multiple uses is more cost effective than purchasing several lasers, each of which perform only one function. In 1995, the purchase price of a pulsed dye laser was ~ $210,000, the main factor in Lutheran's decision to rent the laser rather than purchase it. The current price of a new pulsed dye laser is $159,500. Although more affordable, it is still a tool that can perform only one function (laser lithotripsy). The Holmium:YAG's purchase price in 1993 was $125,000; currently, it is priced at $150,000. The holmium laser initially was a 20 watt unit. It has developed into a 80 watt unit with an increased purchase price. The holmium can be used in almost every surgical speciality, making it a workhorse that pays for itself over the normal amoritazation of captial equipment.

TABLE 1. Comparing Costs

Pulsed dye rental	Pulsed dye purchase
$1,500 × 12 pts. = $18,000 × 5yr = $90,000[a]	$210,000

[a]Currently we are at $18,000 × 3yr = $54,000.

RESULTS

Purchased Pulsed Dye Laser

Cost: $210,000 * 60 (12 × 5) = $3500; price divided by number of cases, will give cost of laser per case. Twelve cases over 5 years = 60 cases. The cost of laser per case is $3,500. Add in the cost of fiber and personnel.

Purchased Holmium:YAG Laser

Cost: 125,000 * 60 (12 × 5) = $2083. We add in ortho cases: 200 ortho cases × 5 years = 1,000 ortho cases + 60 = 1,060; $125,000 * 1060 = $118. Price of the laser divided by total number of cases gives a cost of $118.00 per case. Add in the cost of fiber and personnel.

Our facility performs ~ 12 ureteral lithotripies per year. We realized in 1993 that purchasing a pulsed dye laser was too costly. At that time, the hospital was able to take advantage of renting a pulsed dye laser on a per-case basis. The $1,500 per case charge included the laser, fiber, and a trained laser technician. At that time, this was the best solution for our facility (see Table 1).

In 1995, our facility treated a cystine uric patient who had two calculi in her left ureter. The Holmium:YAG laser, which the hospital owned, was used for laser lithotripsy. After successfully treating the patient with the Holmium:YAG laser, we decided to train the rest of the urologists on the technology. The urologists questioned if our facility was going to stop renting the pulsed dye laser due to its cost. The hospital administration has provided the physicians with a choice of equipment at this time. As the health care industry moves into a completely capitated market, our organization and physicians may not have the freedom of choice in choosing laser equipment in the future. The cost savings of using the Holmium:YAG may mandate the discontinued use of the pulsed dye laser rental. It has already caused the rental company to re-evaluate and reduce their rental fees, to be more competitive in this cost containment market in which we live.

DISCUSSION

There are no comprehensive studies of ureteral perforations with either laser. Drs. John

TABLE 2. Laser Charges to Patient

Pulsed dye rental	Owning the holmium
Laser charge: $1,638	Laser charge: $330
Fiber: included	Fiber: (reusable) 50.25
Technician: included	Technician: 34.70
Total: $1,638.00	$414.95

TABLE 3. Laser Cost-effectiveness

Open ureteral lithotomy		Holmium laser lithotripsy	
Time/or	$ 898.80	Time/or	$1,209.10
supplies	$1,757.95	supplies	$1,405.60
Drugs	$2,314.48	Drugs	$ 312.40
Lab	$1,241.55	Lab (pre-op)	0
X-ray	$ 507.85	X-ray	$ 392.30
Room and board	$1,616.00	Room & Board	0
Recovery room	$ 297.00	Recovery Room	$ 408.00
		Laser	$ 330.00
		Laser fiber	$ 50.25
		Laser tech	$ 34.70
Total	$8,633.63		$4,142.35
Cost difference/savings: $4,491.28			

Denstedt, Hassan Razvi, Jack Sales, and Parker Eberwein have written an article entitled "Preliminary Experience with Holmium:YAG Laser Lithotripsy" [3], a small study of 21 patients who underwent Holmium:YAG laser treatment for ureteral calculi. One patient in the study incurred a ureteral perforation with the holmium laser. The patient was subsequently stented and experienced no further complications.

Graham Watson [4] states his experience with the Holmium:YAG laser. In 6% of ureteral calculi procedures treated with the Holmium: YAG laser, nephrostomy will be required. Another 6% of patients will require a double-J stent due to trauma [4].

James Glenn [5] claims that "the total complication rate of ureteroscopy is about 5 percent, most of which are mucosal injuries." These ureteral injuries are usually treated successfully with ureteral stents. It is unlikely that the physician would not be aware of an injury. An occurrence of an injury so severe that would require an open laparotomy for ureteral repair is also unlikely.

Treatment of cystine calculi patients must be considered. If the holmium laser is not used for lithotripsy, the only option for patients with cystine calculi is an open ureterolithotomy. Recovery time from open ureterolithotomy is longer, more painful, and more expensive.

From this cost-analysis study, Lutheran Medical Center has found that the time required to perform these procedures is no different between that of the holmium and pulsed dye lasers. Providing a good educational practicum will decrease the learning curve of the holmium laser. The efficacy and overall results of the Holmium: YAG laser for ureteral lithotripsy is highly successful and cost effective (see Table 3). Therefore, Lutheran will continue use of the Holmium:YAG laser for ureteral calculi.

REFERENCES

1. Smith Jr, JA, Stein BS, and Benson Jr, RC. "Lasers in Urologic Surgery," 3rd ed. St. Louis: Mosby, 1994:192.
2. Smith Jr, JA, Stein BS, and Benson Jr, RC. "Lasers in Urologic Surgery," 3rd ed. St. Louis: Mosby, 1994, p 192.
3. Denstedt JD, Razvi HA, Sales JL, Eberwein PM. Preliminary experience with Holmium:YAG laser lithotripsy. J Endourol 9(3):255–258.
4. Watson G. Principles of laser stone destruction. In: Smith Jr JA, Stein BS, Benson Jr RC, eds. "Lasers in Urologic Surgery," 3rd ed. St. Louis: Mosby, 1994, pp 183–189.
5. Glenn JF. "Urologic Surgery," 4th ed. Philadelphia: Lippincott 1991, pp 297–298.